

# Stick 'em Up

Preparation Time:	Easy-to-do	Moderate	Extensive
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<b>Grade:</b>	4 – 5
<b>Focus:</b>	Airborne pollutants
<b>Subject:</b>	Social Studies, Science
<b>Materials:</b>	See list below
<b>Teaching Time:</b>	Two class periods (about a week apart)
<b>Vocabulary:</b>	Smog, airborne, particulate matter

4.AIR.3

made particulates. Some of the natural particulates include pollen, wind-blown dust or volcanic ash.

Man-made particulates are generated by coal and oil-fired power plants and manufacturing plants,

automobile and diesel fuels, and fireplaces and wood-burning stoves among others. These **airborne** particulates, or particles carried through the air, can be harmful to plants, animals and humans. Buildings and statues can be discolored.

## Questions for the Class

1. Can we see air pollution? How do we know that air pollution exists?
2. Give examples of visible air pollution.
3. Discuss the concept of particulate matter.
4. List some sources of air pollution, both visible and invisible. Can a single source provide both visible and invisible air pollution?

## Learning Objective

Students will:

- learn that tiny particles are forever floating around in the air we breathe;
- collect, observe, and analyze these particles from various locations around their school or community.

## Background

The air around us is invisible. It is made up of gases that cannot be seen. Many major air pollutants are also invisible gases. In some areas of the country, these air pollutants can build to levels where they can be seen. For example, in some California cities, smoky, yellowish clouds of primarily car exhaust build up to create **smog**.

Other easily visible air pollutants, called **particulate matter**, are made up of tiny particles of solids or droplets of liquids. Some of these particulates are naturally occurring and may pose less of a problem to human health than do man-

## Materials

- *Stick 'em Up* sheet (included) of particulate collectors
- scissors
- clear tape
- string
- hole punch
- magnifying glasses (microscopes optional)
- marker

## Learning Procedure

1. Copy the *Stick 'em Up* sheet (included) so that each student has a particulate collector.



*United States' emissions of sulfur dioxide and nitrogen oxides in the Midwest and Northeast account for about half of the acid rain falling on eastern Canada. Much of acid precipitation falling on Scandinavian countries comes from Britain, Eastern Europe and the former Soviet Union.*

*Source: The Information Please Environmental Almanac, 1993*

2. Cut four holes  $\pm 1.25$ " in diameter in the strip as marked. Using the hole punch, make a hole in the top and tie the string into a loop.
3. Cover one side of the strip with clear tape so that the holes are covered on one side.  
DO-NOT-TOUCH-THE-STICKY-SIDE-OF-THE-  
TAPE-THAT-IS-SHOWING-THROUGH-THE-  
HOLES.
4. Select different sites around the school to hang the Stick 'em Up collectors. On each strip, record the student's name, location, date and time it is hung. Site selections may include inside your classroom, in the hall outside your classroom, in the gym, bathrooms, cafeteria, office, teacher's lounge, outside near a tree, near the parking lot, etc. These should be placed where they can hang freely, not touching other surfaces and where they will not be touched by other students. Be sure to let the custodial staff know about this, too.
5. After a week, retrieve the Stick 'em Up collectors and analyze. First have the students do a cursory inspection, reviewing the strips with the naked eye. What did they find? Next, have them inspect the strips with the magnifying glass or, if you have microscopes, use them instead. What did they find?

### Extension Activity

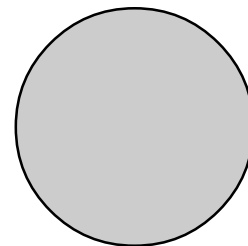
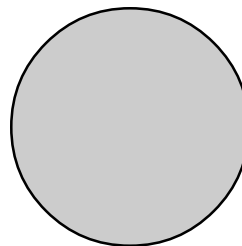
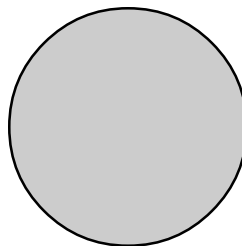
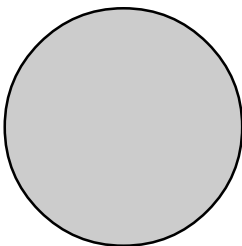
Make a traffic survey. Pick a location where students can observe a busy intersection from a safe distance. Separately record the number of trucks, cars, buses, vans, taxis that pass through that intersection in a given hour. Try this over several days at different times of days.

- **Ask:** What factors influence volume of traffic? (*locations of highways, number of people in the community, shopping centers, businesses, special events, etc.*)
- **Ask:** Did you see evidence of air pollution? (*smells, smoke, wilted plants struggling to survive etc.*)
- **Ask:** Do you think this is a problem? Why or why not. If so, what do you think should be done to correct it?

Name: \_\_\_\_\_

Location: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_



# Today's Forecast...

Preparation Time:	Easy-to-do	Moderate	Extensive
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4.AIR.4

<b>Grade:</b>	4 – 5
<b>Focus:</b>	South Carolina weather patterns
<b>Subject:</b>	Social Studies, Science, Geography
<b>Materials:</b>	See list below
<b>Teaching Time:</b>	One class period plus five days of observations
<b>Vocabulary:</b>	Topography, stagnant, altitude

## Learning Objective

Students will study weather patterns typical in South Carolina.

## Background

Weather patterns are the single most important factor in the movement of airborne air pollutants. In South Carolina, stagnant air is a prevalent phenomenon that often results in hot humid weather during the summer months. Stagnant air traps air pollutants, keeping them in one place. The cause of stagnant weather is a result of South Carolina's geographical location in relationship to prevailing weather patterns.

"We all live downwind" is a saying that has particular relevance in South Carolina. Airborne pollutants can travel great distances...downwind. Some of the air pollution found in South Carolina comes from the Midwest and the Ohio Valley. These pollutants are the ones that form ozone.

Several years ago, severe forest fires in West Virginia blanketed South Carolina with smoke and soot.

The **topography** of South Carolina is divided into two distinct areas commonly known as the Piedmont and the Coastal Plain. The line dividing these two regions runs from the eastern border of Aiken County through central Chesterfield County to the North Carolina border. Along this line, elevation begins at about 3,000 feet and increases in steps of more than 1,000 feet in the extreme northwestern counties with isolated peaks of 2,000 to more than 3,500 feet above mean sea level.

East of the line there is evidence of outcroppings from the lower Appalachian mountains in a ridge of low hill and broken country between the Congaree River and the north fork of the Edisto River. It is also seen in a rather hilly and rolling region in the upper Lynches River drainage basin between the Catawba-Wateree and the Great Pee Dee Rivers. In about one-third of the Coastal Plain, also known as the Upper Coastal Plain, the elevations decrease rather abruptly from 300 feet to 100 feet and lower to the coast. In the lower region to the east and south, great swamp systems predominate.

The slope of the land from the mountains to the sea is toward the southeast and all of South Carolina's streams naturally flow toward the Atlantic Ocean.

The South Piedmont section of South Carolina is on the eastern slope of the Appalachian Mountains. To some extent, these mountains act



*In California, emissions of volatile organic compounds (VOCs) from consumer products such as charcoal lighter fluids, automotive brake cleaner, and disinfectants make up 10 percent of the total nonvehicular VOC emissions. This is about 200 tons per day.*

*Source: The Information Please Environmental Almanac, 1993*

as a barrier for the wind and tend to protect the area from the full force of cold air masses during winter months.

The relatively flat areas of the Central Plains and the coastal region allow free movement of air and effectively disperse pollutants.

The degree to which airborne waste material builds up depends largely on the weather. For instance, measured concentrations of local air pollutants may vary markedly with changing weather even though the total discharge of pollutants remains relatively constant. To evaluate the role that the weather plays in dispersing airborne pollutants, it is important to consider large and small-scale weather patterns. Large scale patterns can usually be determined from the climatological evaluations of existing weather records, available from most National Weather Service Stations. Small-scale weather patterns, on the other hand, are not always easily defined because they depend on various local influences.

Factors that determine how well the weather can disperse air pollution include:

- wind speed, direction and turbulence;
- stability or, more generally, the resistance to vertical motion of the lower layers of air;
- humidity, including condensation such as fog.

The success of wind in moving and dispersing air pollution is based on wind speed. The faster the wind, the faster and more widely air pollutants are

dispersed. Wind direction, with its variations, plays an important role in which way pollutants go.

**Stagnant** air masses occur with varying frequencies in the country. South Carolina experiences one of the highest frequencies of stagnant air in the Eastern United States (see map). Stagnant air masses can produce air pollution episodes.

Stability plays an important role in the weather's relationship to air pollution. Temperature change

and **altitude** determines the stability of the atmosphere. Temperature normally decreases the higher in the atmosphere you go. This is called the **lapse rate**.

Remember that warm air rises. If lower altitude air temperature is close to the temperature of air in higher altitudes, then more energy than normal is needed to move air in its natural cycle from closer to the earth to the upper atmosphere.

When warmer air is at a higher altitude than cooler air this is called a "negative lapse rate," or "temperature inversion" that keeps cooler air closer to the ground from moving to higher altitudes. A temperature inversion can trap air pollutants near the earth's surface, keeping them from being **dispersed**, or spread out, over large areas. Shallow temperature inversions near the earth's surface may be produced nightly with light winds under clear skies. This type of inversion usually breaks up in the late morning as air near the earth warms. If the temperature inversion reaches into higher altitudes, solar heating during the day may not be enough to break up the inversion. South Carolina is subject to a 45 percent chance of inversion on an annual basis.

The role of humidity, including condensation such as drizzle, snow or rain, does not have as great an effect as wind and stability. Condensation as a result of high humidity may cause "rain out" or removal of gaseous air pollutants and particulate matter. Fog, on the other hand, usually limits solar heating which slows down the warming of air closer to the ground and slows down the break up of temperature inversions. Air pollution may also have a direct effect on weather since it can provide particles around which fog may form.

Investigations of air pollution episodes have found all of these weather elements as contributing factors for the accumulation of unusually high concentrations of air pollutants. Light winds, stable conditions and brief periods of fog occurring at the same time is not a rare occurrence, especially in hilly country. Experience has suggested that conditions must persist for several days before high concentrations of air pollution occur. Such

persistent periods are usually associated with the prolonged stagnation of high pressure systems. In the summer, the Bermuda high is the greatest single weather factor. This permanent high usually blocks the entry of cold fronts into South Carolina.

### Materials

- map of South Carolina
- the weather maps from a week's worth of newspapers
- five different colored markers
- wind speed (optional) and direction indicator
- thermometer
- barometer

### Learning Procedure

1. Review with the class the background materials provided with this lesson.
2. In a wide open space on the school grounds, set up the wind speed and direction indicator, thermometer, and barometer. (Note: a wind speed indicator may not be available and can be omitted. You may use a simple weather vane and compass for the wind direction indicator.) Assign students to record the data from these instruments twice a day: once in the morning and once in the afternoon, for five days.
3. On the South Carolina map, plot the weather patterns published in the newspaper. Each day gets a different color marker. Be sure to record temperature extremes and, if provided in your paper, pressure readings.
4. At the end of the week, compare the published weather findings with your class' recordings.

### Questions for the Class

1. How accurate were the published accounts of the weather based on the "reality" of the school yard weather? If they were different, discuss why they might be different.
2. How do weather patterns spread air pollution out over a large area? Is this good or bad?
3. We can't alter the weather. How can we reduce the effect of airborne pollutants?
4. Who lives and works upwind? What pollutants do they produce?
5. Who lives and works downwind? What pollutants does your community produce that travel downwind?

### Extension Activities

1. Visit the National Weather Service office at your local airport or have a meteorologist visit the class. Ask your local TV weather reporter to come and speak.
2. Using the included South Carolina map, find your county and city; identify the dividing line between the Piedmont and the Coastal Plain; and review the Background material. What conclusions can you draw regarding your air quality and topography?



*In California, emissions of volatile organic compounds (VOCs) from consumer products such as charcoal lighter fluids, automotive brake cleaner, and disinfectants make up 10 percent of the total nonvehicular VOC emissions. This is about 200 tons per day.*

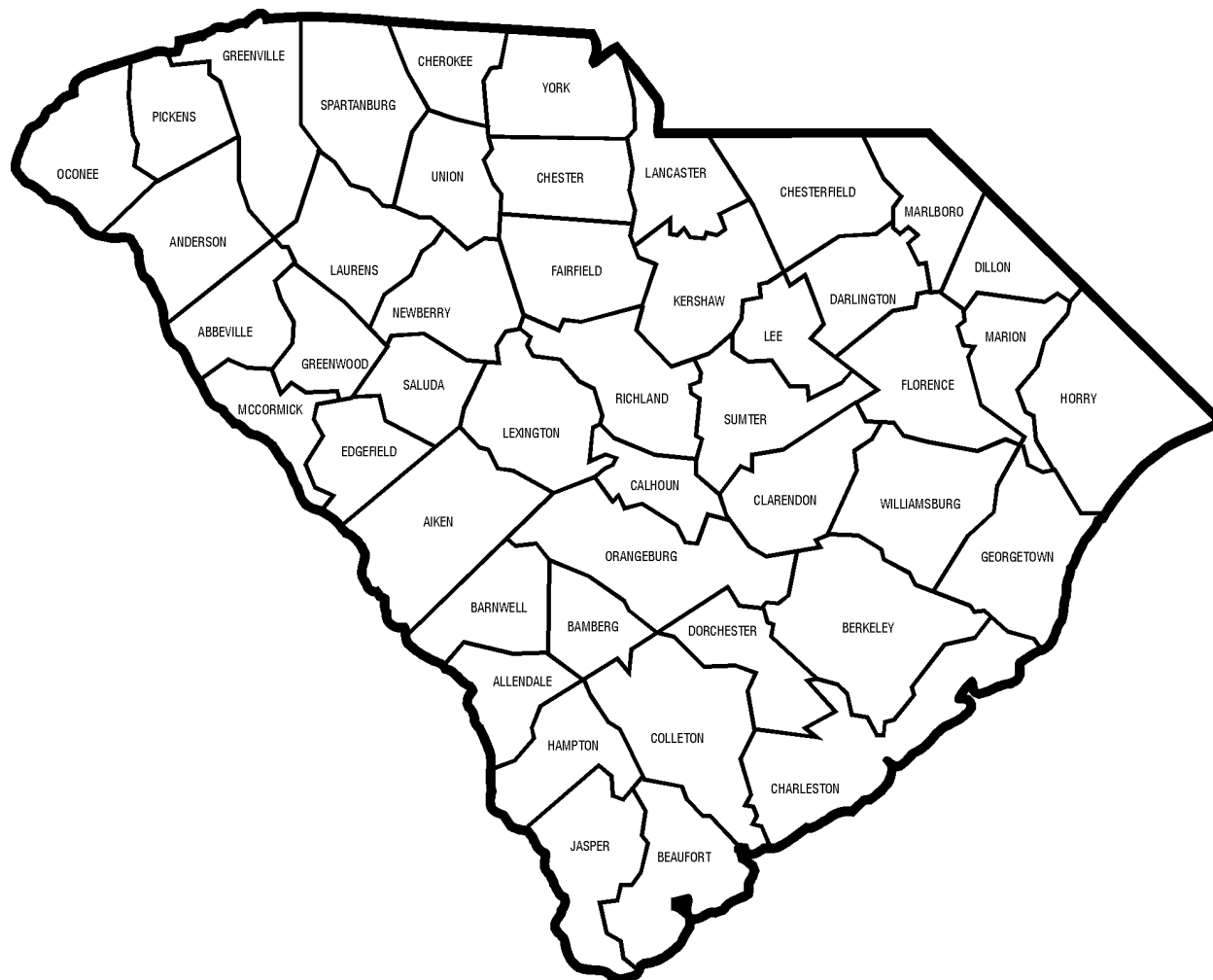
*Source: The Information Please Environmental Almanac, 1993*

# Weather Log

Time	DAY 1		DAY 2		DAY 3		DAY 4		DAY 5	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Temperature										
Barometric Pressure										
Wind Direction										
Wind Speed (optional)										

Observations:

# South Carolina Counties



*An 18 watt fluorescent bulb provides the same amount of light  
as a 75 watt incandescent bulb and lasts ten times as long.*

*Source: The Handy Science Answer Book, 1997*



*The Beaufort Scale uses a series of numbers from zero to 17 to indicate wind speeds; the scale applies to winds on land and the ocean.*

*Source: The Handy Science Answer Book, 1997*

# The Air in Here

Preparation Time:	Easy-to-do	Moderate	Extensive
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Grade:	4 – 5
Focus:	Indoor air
Subject:	Social Studies, Science
Materials:	None
Teaching Time:	One class period
Vocabulary:	Toxicity

4.AIR.5

windows closed contributes further to the problem of bad air trapped indoors. This problem is not confined just to your home either. Many hotels, shopping malls and other public buildings now have windows that do not open.

There are other factors that make us victims of bad indoor air. Pesticides, certain appliances, building materials (carpets, insulation, paint, etc.), detergents, certain perfumes, hairsprays and cleaners are examples of products that bring harmful pollutants to the inside where they are trapped and become part of the air we breathe. Most public buildings now have bans on smoking because cigarette smoke is suspected of causing problems with those who do not smoke.

When we think of air pollution, we usually think of all the causes and forces that combine to give us a quality of air lower than we really should be breathing. Most of the publicized reports deal with the problems of the air outside. In reality, the toxicity of indoor air can be as much as 10 times the level of outside air. This is the air inside our homes, the air we breathe when we eat, sleep and spend time relaxing with our families and friends.

There are a number of factors involved in the origination of bad air, many of which can be eliminated or reduced through simple and inexpensive common-sense steps. Others are more difficult and expensive to correct. However, if someone suffers from unusual symptoms, it might be worth the trouble to test and find out what kind of bad air may be in the home. Every home is different, and some may contain a variety of potentially harmful gases or pollutants...some not.

In many areas of the country, but not in South Carolina, people are greatly concerned about

## Learning Objective

Students will learn that air pollution is not just something that happens outdoors; it's indoors, too.

## Background

When you mention air pollution, students and adults usually think about emissions of automobiles, pollutants sent into the air by industry, acid rain, tobacco smoke and burning wastes. These topics are often the focus of news reports and so they are the only kinds of air pollution we are accustomed to hearing about. However, there is also a problem on the inside. The **toxicity** of air indoors is often much greater than that found outdoors

Sources of indoor air pollution are varied; from poor ventilation to harmful vapors released by furniture and carpets; from asbestos insulation to radon gas seeping from the ground under the house; from tobacco smoke to cleaning products.

We have become more energy-efficient in recent years. This is good for the environment. However, one of the effects of this is that our homes are not ventilated as well as they were in the past. Keeping



*The Pollutant Standard Index measures the amount of air pollution in parts per million and has been used nationwide since 1978. It was devised to monitor concentrations of pollutants in the air and inform the public concerning related health effects.*

*Source: The Handy Science Answer Book, 1997*

radon. Radon is a colorless, odorless, inert gas that is released when uranium-laced soil decays into radioactive particles. Radon levels vary from day to day depending on the moisture content of the soil and changes in ventilation. Homes that are susceptible to radon exposure have basements, not a common home feature in South Carolina; or homes built on a slab of concrete poured directly onto the ground. Homes with a crawl space, like most houses in South Carolina, have adequate ventilation to remove any build up of radon.

Asbestos is another common source of indoor air pollution. For many years, asbestos, a fibrous mineral that will not burn readily, was used in homes, schools, and offices as fireproofing and electrical insulation. We have since learned that minute particles of asbestos can flake off, becoming airborne where they can be breathed by the occupants of the building. Asbestos has been found to cause cancer and is therefore no longer used in new construction. However, many older buildings still have asbestos in them. Building codes require that, if any renovations take place in an older building and asbestos is found, it must be removed from the building before renovations are completed.

### Questions for the Class

1. Some people are more at risk from indoor air pollution than others. What additional risks are posed to the elderly and to young children when they are exposed to a continued assault of bad air?
2. What effects will a depleted ozone layer pose to indoor air pollution?
3. Discuss the health problem known as Chemical Hypersensitivity Syndrome (CHS) where, in extreme cases, sufferers often have to live in a "bubble" or an environment where the atmosphere is constantly and thoroughly cleaned of all chemicals and pollutants. What are the health risks to those with CHS?

### Learning Procedure

1. Share the Background material with your students.
2. Divide them into groups and have one group survey their homes and the other survey the

school. Make sure they record evidence of good ventilation as well as bad; and point to specific products and materials that are harmful to the indoor environments that are part of our lives on an almost daily basis. Have them report their findings to the other group.

3. After hearing the group reports, discuss as a class or write a report on where they contribute to indoor air pollution and where they can make a difference in the indoor air where they live and learn. "What can you do to help make your own indoor environment safer and less polluted?"
4. Point out examples of specific household products that may contribute to bad air in the home. This is more of an assessment than anything else and discussion can lead to questioning whether substitute products might be used, or the use of certain products eliminated altogether.
5. As a class, brainstorm ideas that can be used around your school, or at home, to improve indoor air. Elect two representatives from the class to present your survey findings and your list of suggested solutions to your school improvement council or your principal. Take these ideas and use them at home. Ideas may include:
  - spend more time outdoors;
  - make use of air cleaners and air purifiers;
  - avoid the use of halon fire extinguishers;
  - take steps to provide better ventilation in your home and classroom;
  - avoid use of highly toxic cleaning agents, drain cleaners, furniture polish, pesticides, fabric softeners, disinfectants, perfumes and hair sprays.

### Extension Activity

Research Chemical Hypersensitivity Syndrome (CHS). When did this first show up in the medical field? Which chemicals are most harmful to people who suffer from CHS? Where are these chemicals found? How do sufferers cope with their allergies? What can be done to help them? Why are they sensitive to chemicals? Is there anyone in your community who suffers from CHS?

# Acid Rain and Plants

<b>Preparation Time:</b>	<b>Easy-to-do</b>	<b>Moderate</b>	<b>Extensive</b>
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4.AIR/EPA.1

<b>Grade:</b>	4 – 6
<b>Focus:</b>	Acid rain
<b>Subject:</b>	Science
<b>Materials:</b>	Three small, healthy potted plants of the same type, three large jars with lids, vinegar, water, measuring cup, masking tape, paper, pen
<b>Teaching Time:</b>	One class period (with possible extensions)
<b>Vocabulary:</b>	Acid rain, acidic, alkaline, base, logarithm, neutral, pH, precipitation

## Learning Objectives:

Students will:

- observe the impact of acids on plants;
- recognize how acid rain can affect the environment by observing and comparing.

**NOTE TO TEACHERS:** This activity lets students observe the effects of acid rain on plants in a simulated experiment using vinegar or lemon water. The results from the experiment could be used as an introductory presentation to an SCDHEC – Bureau of Air Quality representative who is an expert on acid rain. The representative could then follow up with a presentation to the class about EPA's efforts to reduce acid rain in the United States and internationally.

## Background

Acid rain is precipitation that is more acidic than normal. The terms “acidic” and “basic” (or “alkaline”) are used to describe two chemical extremes, much like hot and cold describe two temperature extremes. Mixing acids and bases can

cancel out their extreme effects, much like mixing hot and cold water moderate the temperature. A substance that is neither acidic or basic is called “neutral.” The pH scale measures how acidic or basic a substance is. The pH scale ranges from 0 to 14. A pH of 7 is neutral. A pH lower than 7 is acidic; higher than 7 is basic. Pure water is neutral. But when chemicals are mixed with water, the mixture can become either acidic or basic. For example, lemon juice is acidic; the pH of lemonade is between 2 and 3. Ammonia, on the other hand, is alkaline; its pH is just over 11. Each unit of pH is ten times greater or smaller than the next unit. For example, a pH of 5 is 100 times more acidic than a pH of 7. This is called a “logarithmic” scale.

Air pollution is a major cause of acid rain. When precipitation becomes more acidic than normal, it can damage soil, water, building materials, plants, animals, and humans. The effects of acid rain may not be immediately apparent in all places. For example, at a glance, a lake might look clear and beautiful. But when you look closely, you might begin to see some problems. Where are the fish? Why are there few or no plants? Many lakes in the Adirondack Mountains of New York, the upper midwest, and many streams in the Appalachian Mountains, in particular, have experienced losses of aquatic life. Nature can cope with some changes in acidity. Areas with limestone (which reacts with acid) are able to neutralize acidic rainfall so the damage is reduced. However, large parts of the world do not have this acid rain coping ability and, in any case, no area can handle very large amounts of acid rain.

Acid rain can affect plants in many ways. It takes nutrients away from the soil so that plants can't grow. It weakens trees so that they become diseased more easily. Branches at the top of trees lose their leaves. Tree leaves might be an unusual color. Trees may not have as many leaves or may

lose their leaves earlier each year. Eventually, trees die. In this experiment, with potted plants, the more acid rain in the plant water, the sooner a plant dies. The plants are watered with solutions that have a lower pH than most rain-fall. (See reading materials on “Air Pollution” and “Acid Deposition” in the Resource Section.)

### Learning Procedure

1. Divide the class into three teams. Give each group a 1-gallon container (a milk container would work). Have one team fill their container with 1 gallon (3.8 liters) of tap water. They can use a piece of masking tape to label the container “tap water.”
2. Have another team fill their container with 1 pint (0.5 liters) of vinegar and 7 pints (3.3 liters) of tap water. Have them use a piece of masking tape to label the container “slightly acidic.”
3. Have the third team fill their container with 2 pints (0.9 liters) of vinegar and 6 pints (2.8 liters) of tap water. Have them use a piece of masking tape to label the container “very acidic.”
4. Give each team one of the plants and have them label it the same as their container. Make each team responsible for watering their plant from the container with the matching label.
5. Place all three plants in the same spot so that they get the same amount of light. Students should water the plants when they need it (every two to four days). Make sure the plants get the same amount of water in each watering cycle. Have team members examine their plants every day and write down what they look like—what color they are, if their leaves are dropping, whether they look healthy.
6. Continue this activity for two to three weeks. Then have students examine the plants and discuss the results of the experiment. What happened to the plants watered with acid solutions? How long did it take to see the effects of the acid? Do the plants differ in

color? If so, why? Which plant showed the most effects?

### Extension Activity

1. If you live in an area affected by acid rain, take students on a field trip and have students write down what they observe about the area. Can they see dying or dead plants or trees, stained or eroded building surfaces or statues? If there is a lake or stream nearby, can they see any wildlife? Discuss ways that the area may be saved. Discuss the sources of the pollution that may have contributed to the acid rain that falls in the area.
2. In a follow-up class with an SCDHEC – Bureau of Air Quality representative working on acid rain, have the students present their results from the experiment. The SCDHEC representative could discuss the results and provide some additional information on acid rain.

### Suggested Reading

*Acid Rain Kids Handbook*. Washington, DC: National Geographic Society (1988).

*Acid Rain: The Invisible Threat* (VHS videotape). Scott Resources (1992).

Baines, John. *Conserving Our World, Conserving the Atmosphere*. Austin, TX: Steck-Vaughn Company (1990).

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Lucas, Eileen. *Acid Rain*. Chicago: Children's Press (1991).

McCormick, John. *Acid Rain*. Gloucester Press (1986).

Miller, Christina G., and Louise A. Berry. *Acid Rain: A Sourcebook for Young People*. New York: Julian Messner (1986).

O'Neill, Catherine. "Saving Statues from Acid Rain." *Washington Post* (Washington Health), 116 (6 April 1993) p. WH18.

Pringle, Laurence P. *Rain of Trouble: The Science and Politics of Acid Rain*. New York, NY: Macmillan (1988).

*Problems of Conservation: Acid Rain* (VHS videotape). EBE (1990).

Stubbs, Harriet, Mary Lou Klinkhammer, and Marsha Knittig. *Acid Rain Reader*. Raleigh, NC: Acid Rain Foundation (1989).

*This lesson was adapted from the EPA publication Project A.I.R.E. – Air Information Resources for Education (K-12).*



***Do you have questions about acid rain. Call the Acid Rain Hotline at (202) 233-9194 to request related materials.***